United States
Department of
Agriculture

**Forest
Service**

Southwestern
Region

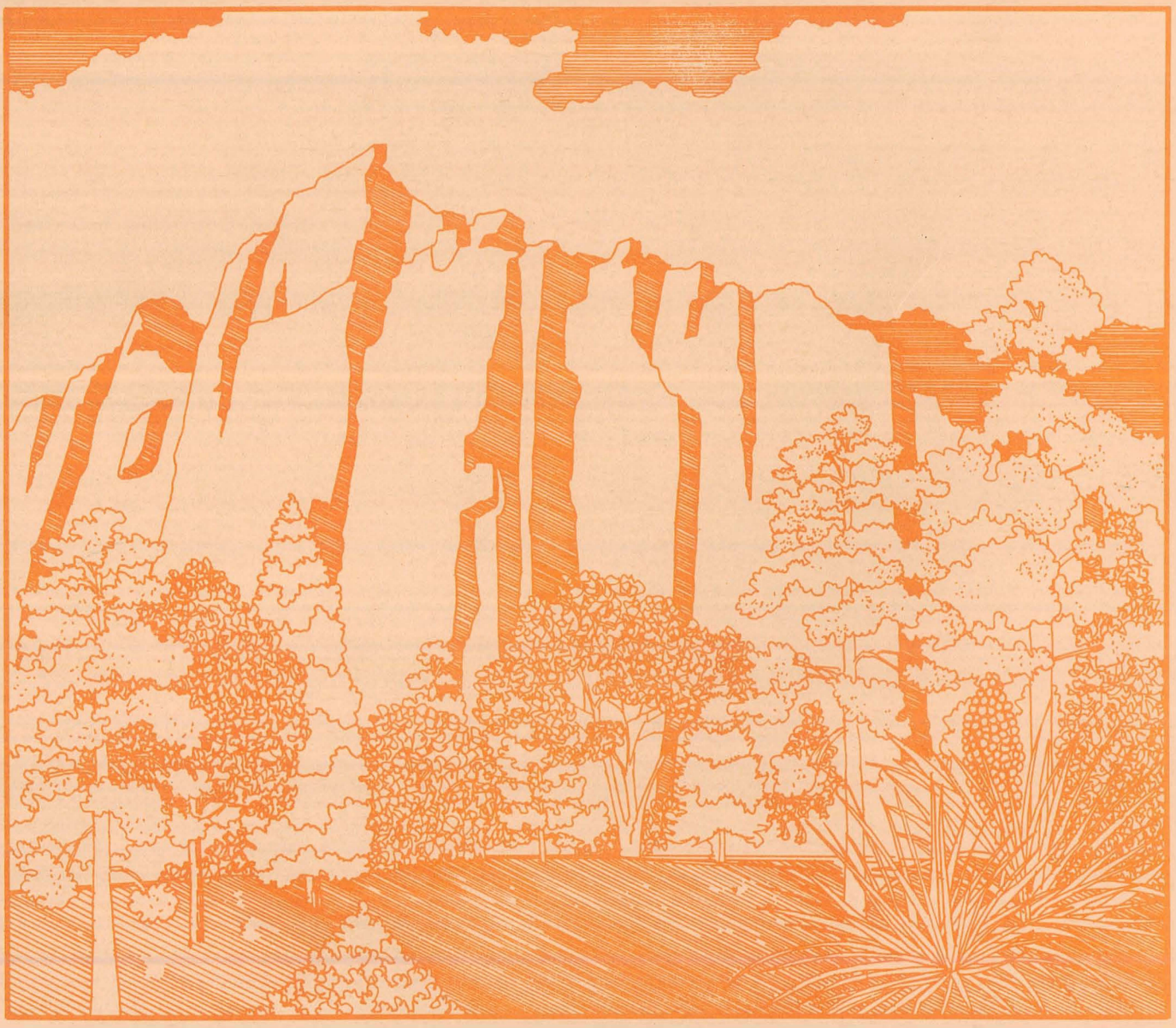
Forest Pest Management Report

R-3 83-3

BIOLOGICAL EVALUATION
Western Spruce Budworm

Santa Fe National Forest, Jemez Indian
Pueblo, and Santa Clara Indian Pueblo
New Mexico

December 1982



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USDA Forest Service, Southwestern Region
State and Private Forestry
Forest Pest Management
517 Gold Avenue, SW
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ABSTRACT

Western spruce budworm, Choristoneura occidentalis Free., infestations increased throughout the Jemez Division of the Santa Fe National Forest and adjoining lands of mixed ownership. A total of 187,600 acres of defoliation, as detected by aerial detection surveys, was recorded on the Santa Fe National Forest and adjoining lands in 1982. Average egg mass densities increased in most areas sampled in 1982. Light to moderate defoliation is expected in 1983 in the Jemez West, Jemez Spray, and Jemez North entomological units. Moderate to heavy defoliation is expected in 1983 on the Jemez East entomolgical unit. The Santa Clara Pueblo Indian Reservation is a part of the Jemez East entomological unit and light to moderate defoliation is expected in 1983. The Jemez Pueblo Indian Reservation is in the Jemez East and Jemez Spray entomological units. Both areas are expected to have moderate to heavy defoliation in 1983. Areas of moderate and heavy defoliation occur on all entomological units and are expected to expand in 1983, barring unforeseen natural mortality factors such as inclement weather. Pest management alternatives and recommendations are discussed.

INTRODUCTION

The western spruce budworm, Choristoneura occidentalis Free., continued to cause defoliation in mixed conifer stands on the Santa Fe National Forest. Visible defoliation[1] was first reported on the Jemez East and Jemez West entomological units in 1976 and on the Jemez Central entomological unit in 1977. In 1977, the Jemez Spray unit was aerially treated with carbaryl to suppress the budworm infestation.

Egg mass density surveys were conducted on all four entomological units. Due to expanding infestations, the entomological units were realigned in 1981. Results are summarized in this evaluation, and management alternatives and recommendations are presented.

TECHNICAL INFORMATION

Insect. Western spruce budworm, Choristoneura occidentalis Freeman

Hosts. Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History. The western spruce budworm completes one generation each year (Furniss and Carolin 1977).

Stage	Time	Location on host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Large larvae	June	On buds and strobile
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation

1. Young larvae feeding on newly expanding buds and strobile.
2. Mature larvae consuming current year's needles.
3. Shoots webbed together by larvae.
4. Webbed shoots turning brown and falling from trees.
5. Defoliation most evident in upper crowns of trees.
6. Trees dying from the top downward after several years of heavy defoliation.

[1] Visible defoliation based on aerial detection surveys.

Extent of Defoliation in 1982. Defoliation was observed by aerial detection surveys on 187,600 acres of the Santa Fe National Forest and adjoining lands in the Jemez Mountains, including the Baca Location. Acres of defoliation by intensity classes were: Light, 85,660 acres; moderate, 81,735 acres; and heavy, 20,205 acres. Figures 1 to 5 show the extent and intensity of defoliation.

HOST STAND CONDITIONS

It appears that most western spruce budworm-infested areas are contiguous, multistoried, overstocked mixed conifer stands. These stand conditions increase the possibility and severity of permanent tree damages caused by western spruce budworm. Understory trees, seedlings, saplings, and poles are particularly susceptible to severe damages. Top-kill is occurring off of Forest Road 289 near Obsidian Ridge and Alamo Canyon, near Fenton Lake, west of Los Alamos, and north of San Pedro Parks Wilderness Area.

BIOLOGICAL INFORMATION

Relative Abundance of Pest

Methods. Egg mass surveys were conducted in August to estimate defoliation in 1983. Two branches (70 cm in length) were cut from opposite sides of the midcrown of three sample trees on plots located in each of the entomological units. Sample trees met the following criteria: Douglas-fir, dominant or codominant; 30 to 50 feet in height; relatively open-grown with a full crown; and some budworm feeding evident, but not severely defoliated or top-killed. Each branch was individually bagged in cloth sacks, tied securely, labeled, and transported to a laboratory for examination. Foliage was stored in a walk-in cooler at about 40° F until examined.

In the laboratory, foliage was examined under ultraviolet light for egg masses. Needles with egg masses were classed as from current year's foliage or a previous year's foliage and kept separate in labeled pill boxes. New and old egg masses were separated by an experienced laboratory technician. All egg masses on current year's foliage were classed as new and their characteristics formed the basis for aging egg masses found on previous year's foliage.

Defoliation estimates for 1983 were determined from the density of 1982 egg masses using the following information presented by McKnight et al. (1970):

Egg mass density[a]	Predicted defoliation class[b]
1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations

9.30 to 31	Light for "static" infestations Moderate for "increasing" infestations
34.10	Moderate for "static" infestations Heavy for "increasing" infestations

[a] Number of egg masses per square meter of foliage.
[b] Defoliation class limits (percent of new growth).
Undetectable = <5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = >65 percent

Results and Discussion

Entomological units have been divided into geographically separate units in conformance with the environmental analysis currently underway on the Forest (figures 6 and 7).

The extent and severity of the infestation increased in 1982. The Jemez West and Jemez North entomological units, in particular, had large increases in acres defoliated. The results of the egg mass survey are discussed by entomological units below and are summarized in table 1.

Jemez East Entomological Unit. This unit consists of parts of the Jemez, Espanola, and Tesuque Ranger Districts, and the Los Alamos and Peralta analysis units. Egg masses per square meter of foliage rose from 30.4 in 1981 to 39.4 in 1982 (table 1). Total acreage defoliated in 1982 was 50,420 acres, compared to 57,700 acres in 1981 (table 1). Defoliation occurred from Vallecitos de los Indios east and then north to the Santa Clara Pueblo Indian Reservation. Adjacent areas of the Baca Location No. 1, Bandelier National Monument, and the Los Alamos National Laboratory were also defoliated (figure 1). The majority of the defoliation was classified as moderate.

Defoliation is expected in the same areas in 1983 at moderate to heavy levels as detected by aerial detection surveys, since the cumulative effect of 4 consecutive years of defoliation will increase the severity of defoliation. Also, growth loss and top-kill, particularly in post-, pole-, seedling-, and sapling-size classes, are expected.

Jemez West Entomological Unit. This unit consists of parts of the Jemez, Coyote, and Cuba Ranger Districts and was divided into the Rio de las Vacas and San Pedros analysis units. The unit was created in 1981 from the Jemez Central entomological unit and the Coyote

Ranger District (Ragenovich 1980) due to integration of separate infestations (Telfer 1981). Egg masses per square meter of foliage increased from 21.4 in 1981 to 28.8 in 1982 (table 1). Total acreage defoliated increased from 51,410 acres in 1981 to 101,035 acres in 1982. Defoliation occurred on most of the host type in the entomological unit (figure 2). The majority of the defoliation was classified as light.

Defoliation is expected in the same areas in 1983 at light to moderate levels, as detected by aerial detection surveys; however, moderate to heavy defoliation is expected to continue in the north and northeast sides of the San Pedro Parks on the Coyote Ranger District. Since most of the area defoliated has not been defoliated for more than 2 years, few significant permanent tree damages are expected to occur for several more years. Several areas that are already experiencing permanent tree damage, particularly top-kill, are: The previously described areas north of San Pedro Parks; and the Barley Canyon, Fenton Lake, and Schoolhouse Mesa areas where heavy defoliation has occurred for a number of years on the north aspects of ridges running east-west.

Jemez Spray Entomological Unit. This unit consists of parts of the Cuba Ranger District and the Jemez Pueblo Indian Reservation, and is part of the Rio de las Vacas analysis unit (figure 3). This unit is considered separately from the Jemez West entomological unit because it was sprayed with carbaryl for western spruce budworm control in 1977 (Parker et at. 1980). Egg masses per square meter of foliage increased from 6.1 in 1981 to 13.3 in 1982 (table 1). Total acreage defoliated increased by 7,000 acres from 1981 to 1982 (table 1). Areas of defoliation are: On Mesa Venado; from Bales Seep north to Trail Creek; on Big Mountain; on Red Top; from near Red Top north to Windy Canyon; from Horseshoe Spring east to Rio de las Vacas; and on Eureka Mesa (figure 3). The majority of defoliation was classed as light.

The 1982 egg mass density and the number of acres defoliated are both greater than the 1976 levels, the year prior to direct treatment with carbaryl (13.3 egg masses per square meter of foliage and 17,500 acres defoliated in 1982 versus 8.1 egg masses per square meter of foliage and 2,400 acres defoliated in 1976). It thus appears that an acceptable direct treatment, 87.5 percent adjusted mortality, can keep western spruce budworm populations low for 4 to 5 years before prespray population levels are reached again. The results of monitoring the effects of the 1977 spray project for a sixth year will be discussed in detail in an upcoming report.

Defoliation is expected to expand into previously uninfested areas and become more severe in currently infested areas. Although the infestation may reach intensity levels equal to the Jemez West entomological unit within the next several years, tree damages are expected to be less due to less cumulative defoliation.

Jemez North Entomological Unit. This unit consists of part of the Espanola Ranger District and the Santa Clara Pueblo Indian Reservation, and is basically the same as the Abiquiu analysis unit (figure 4). Egg masses per square meter of foliage dropped from 51.3 in 1981 to 19.3 in 1982. Acres of defoliation increased from 5,850 in 1981 to 14,430 in 1982 (table 1). Defoliation occurred from Canoncito Seco east to El Recheulos and from Abiquiu Creek south to the Santa Clara Pueblo Indian Reservation (figure 4). The majority of defoliation was classified as light to moderate.

Although egg mass densities dropped significantly, defoliation is expected to increase in 1983, but remain at light to moderate levels. This is exactly what occurred on the Jemez West entomological unit from 1981 to 1982.

Tesuque Entomological Unit. This unit consists of part of the Tesuque Ranger District and parts of the Tesuque and Nambe Pueblo Indian Reservations. The unit includes all host type west of a ridge that runs from North Truchas Mountain south to Glorieta Pass. In 1982, western spruce budworm defoliation was observed by aerial detection for the first time in recent years. Approximately 25 acres of moderate defoliation were recorded northeast of Thompson Peak. An egg mass plot was established at Black Canyon campground. Western spruce budworm activity was observed, but no egg masses were found. Western spruce budworm populations are expected to remain at endemic levels.

MANAGEMENT ALTERNATIVES

Maintain Present Management. With this no action approach, the outbreak will run its course until a population collapse occurs from a combination of: (a) A lack of foliage to maintain a larval population; (b) unfavorable weather conditions; (c) heavy predation and parasitism; and (d) a microbial epizootic. Adverse and beneficial effects of the outbreak are accepted. These are:

1. This alternative would not be effective in preventing additional tree damages. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative. Although damages resulting from the western spruce budworm in the Southwest are not completely known, maximum damages similar or higher than those estimated for the northern Rockies could occur if the outbreak continues unabated. These include the following:

Tree damages	Maximum damages (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Top-killing	25
Cone crop reduction	90+
Christmas tree use reduction	90+

2. There would be no direct costs associated with selection of this alternative, although timber values will be affected and revenues reduced when severely damaged stands are harvested. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation.

3. Visual qualities and economic and social impacts would result if this alternative were selected.

Direct Suppression. Aerial application of a chemical insecticide registered by the U.S. Environmental Protection Agency (EPA) could be done to suppress the entire outbreak in the Jemez Mountains or on the entomological units that would gain the greatest benefits. Partial sprays may also be desirable as buffer zones for other landowners that opt for chemical treatment.

Application must be carefully timed to the development of the larvae, when 20 percent of the larvae are in the fifth and sixth instars. This insures maximum effectiveness with minimum dosage.

Effects of this alternative are:

1. Tree damages prior to treatment are accepted and will reduce the benefits of treatment, but further, more serious losses will be prevented.

2. It would cost about $9 per acre to suppress the current outbreak.

3. Adverse environmental effects from aerial application of a pesticide would be minimal and temporary.

Insecticides registered for use against the budworm follow:

1. Carbaryl (carbamate insecticide)

The Sevin 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West. An outbreak on the Santa Fe National Forest was successfully suppressed in 1977, and the outbreak has remained at a low level for 5 years (Parker and Ragenovich 1980). Carbaryl is a nonpersistent pesticide which is available for general use. One pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene Forest Spray (acephate) is a nonpersistent insecticide registered for use against the western spruce budworm and other forest defoliators. Although this insecticide has been shown to be effective against the budworm, it has never been used in the Southwest.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad-spectrum insecticide, registered for use against more than 100 insects, including the western spruce budworm. However, it is not recommended because it has yielded inconsistent results in suppressing outbreaks.

4. Microbial Insecticides

Microbial insecticides, such as Bacillus thuringiensis (B.t.), a bacterium, and viruses need further research testing and field evaluation before they are ready for use. In June 1981, two B.t. formulations were tested by USDA Forest Service and New Mexico Department of Agriculture near Eagle Nest, New Mexico. Preliminary results show that larval mortality was greater in sprayed areas than in check blocks; however, additional data analysis still needs to be done. B.t. could be used for treatment in sensitive areas, such as along stream courses, where a chemical pesticide would not be acceptable.

Treatment of High-Value Trees. In recreation areas, VIS centers, and other areas where defoliation of high-value trees would be unacceptable, individual or small groups of budworm-infested trees could be treated by a ground application of an EPA-registered insecticide to reduce the larval density and prevent the adverse effects of defoliation.

Effects of this alternative are:

1. Because only selected high-value trees within an infestation could be treated, this would require annual applications during the outbreak cycle, since treated trees would be reinfested from the nearby infested stands.

2. Application costs associated with this alternative would be relatively low and cost effective.

3. Adverse environmental effects would be minimal and temporary.

Silvicultural Management. The main objective of this alternative is to promote effective timber management of the mixed conifer type to reduce the impact of future outbreaks. The pest management component of this alternative is to create stand conditions that reduce tree damages over the long term. For example, prescriptions should: (a) Open up stands by logging, thinning, and burning; (b) maintain stand densities favoring ponderosa pine and aspen; (c) favor prescribed burning to reduce the percentage of firs and Engelmann spruce; (d) regenerate stands by artificial means using ponderosa pine stock; (e) favor a mosaic of different age class, single-storied stands; and (f) salvage damaged and insect-killed trees.

Effects of this alternative are:

1. The trend of the current outbreak would not be changed if a silvicultural program were initiated. Tree damages would be the same as those listed under "Maintain Present Management."

2. Visual qualities and social and economic impacts would result.

RECOMMENDATIONS

Jemez East Entomological Unit. Feasible management alternatives for this unit are: Maintain present management, silvicultural management, and direct treatment of high-value trees. Direct suppression is not considered a viable alternative, biologically or economically, because the western spruce budworm has been at epidemic levels on the unit for a number of years and permanent tree damages have already occurred. The recommended alternative is silvicultural management to manipulate stands to reduce the impact of future western spruce budworm infestations.

Jemez West Entomological Unit. All four management alternatives are feasible in 1983. Direct suppression will not be feasible within 1 to 2 years because permanent tree damages will be occurring throughout most of the infested area. The recommended alternative is maintain present management in the short term and silvicultural managment as a long-term policy. Direct suppression would be difficult due to logistics problems and the pockets of permanent tree damages that have already occurred.

Jemez Spray Entomological Unit. Recommendations for this unit are identical to those discribed for the Jemez West unit.

Jemez North Entomological Unit. All four management alternatives are viable in 1983; however, direct suppression will not be feasible in 2 to 4 years because permanent tree damages will have occurred. If management objectives and resource values warrant, direct suppression is the recommended alternative. If direct suppression is not economically justified, maintain present management is the recommended alternative for the short term, and silvicultural management is recommended for the long term.

Tesuque Entomological Unit. Management alternatives available are maintain present management and silvicultural management. Western spruce budworm populations are currently too low to justify any direct treatments. Recommended alternatives are silvicultural management in stands that can be entered, and maintain present management in stands that cannot be entered, such as the Pecos Wilderness and the Santa Fe Municipal Watershed.

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APPENDIX

TABLE 1.--Summary of egg mass density and aerial detection survey on the Jemez East, West, Spray, and North entomological units, Santa Fe National Forest, 1981

Jemez East entomological unit

		1976	1977	1978	1979	1980	1981	1982 $\bar{x}$	1982 SE
New egg masses/ sq. meter foliage		16.9	12.7	12.1	18.9	58.3	30.4	39.4	8.6
Buildup ratio		---	0.7:1	0.9:1	1.6:1	3.1:1	0.5:1	1.3:1	
Actual defoliation (acres)	L	2,520	56,872	3,309	1,638	22,880	15,200	12,810	
	M	2,440	1,556	503	512	18,635	39,200	27,115	
	H	0	0	0	0	2,560	3,300	10,495	
	TOTAL	4,960	58,428	3,812	2,150	44,075	57,700	50,420	

Jemez West entomolgical unit

		1976	1977	1978	1979	1980	1981	1982 $\bar{x}$	1982 SE
New egg masses/ sq. meter foliage		---	4.3	6.1	9.7	44.2	21.4	28.8	7.0
Buildup ratio		---	---	1.4:1	1.6:1	---	0.5:1	1.4:1	
Actual defoliation (acres)	L	0	435	512	716	7,370	12,810	51,700	
	M	0	589	418	0	7,885	30,000	42,010	
	H	0	0	0	0	3,610	8,600	7,325	
	TOTAL	0	1,024	930	716	18,865	51,410	101,035	

Jemez Spray entomological unit

		1976	1977	1978	1979	1980	1981	1982 $\bar{x}$	1982 SE
New egg masses/ sq. meter foliage		12.6	1.7	0.5	0.6	4.9	6.1	13.3	1.8
Buildup ratio		---	0.1:1	0.3:1	1.2:1	8.2:1	1.2:1	2.2:1	
Actual defoliation (acres)	L	8,400	1,894	0	486	4,500	1,025	11,490	
	M	3,800	218	0	563	1,460	8,775	4,875	
	H	240	0	0	0	0	325	1,135	
	TOTAL	12,440	2,112	0	1,049	5,960	10,125	17,500	

TABLE 1 (cont'd)

	Jemez North entomological unit		
	1981	1982	
		$\bar{x}$	SE
New egg masses/ sq. meter foliage	51.3	19.3	4.6
Buildup ratio	---	0.4:1	
Actual defoliation (acres) L	3,300	9,825	
M	1,775	4,105	
H	775	500	
TOTAL	5,850	14,430	

L = Light
M = Medium
H = Heavy

FIGURE 1.--Western spruce budworm defoliation, Jemez East entomological unit, Santa Fe National Forest, 1982

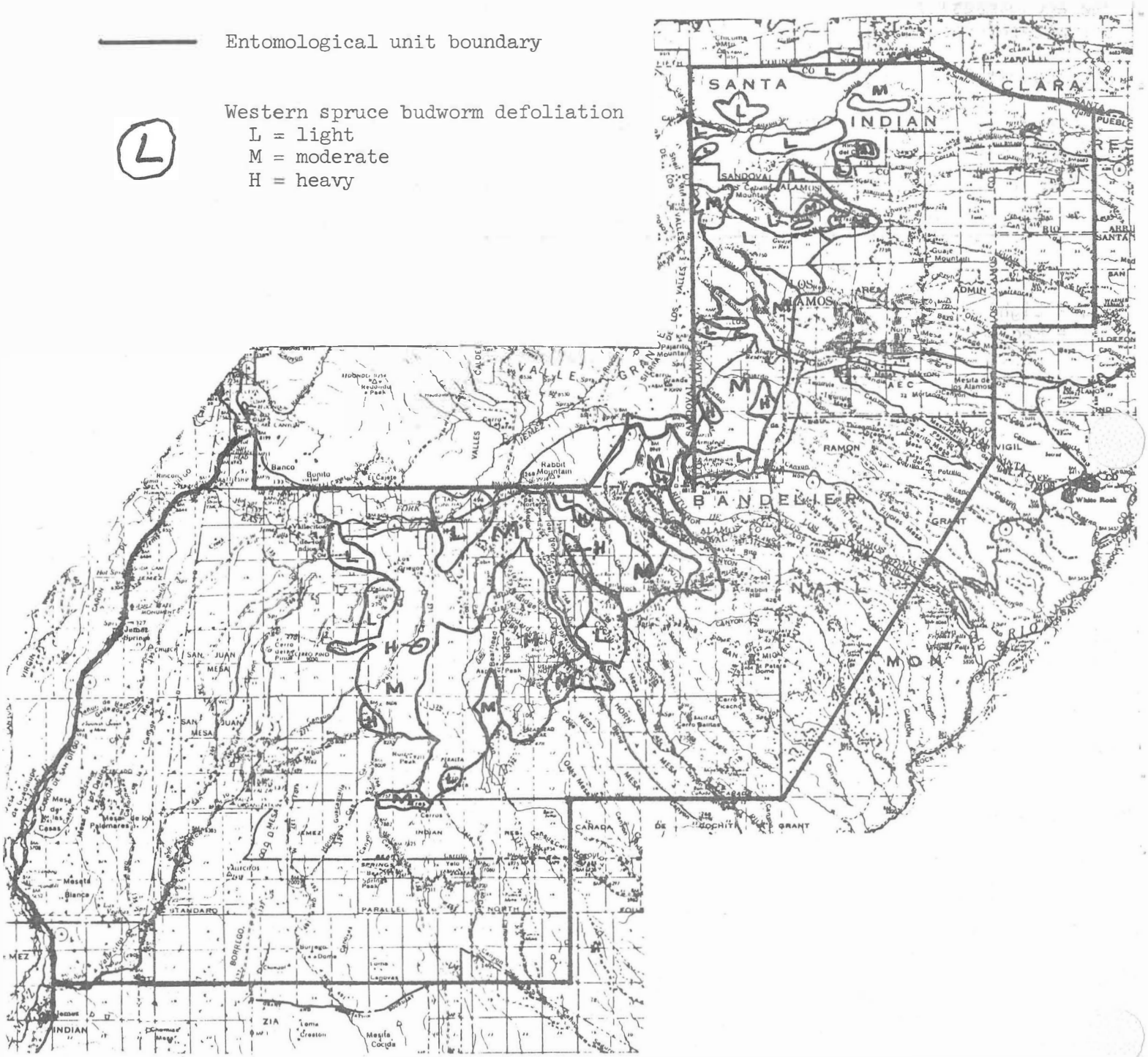


FIGURE 2.--Western spruce budworm defoliation, Jemez West entomological unit, Santa Fe National Forest, 1982

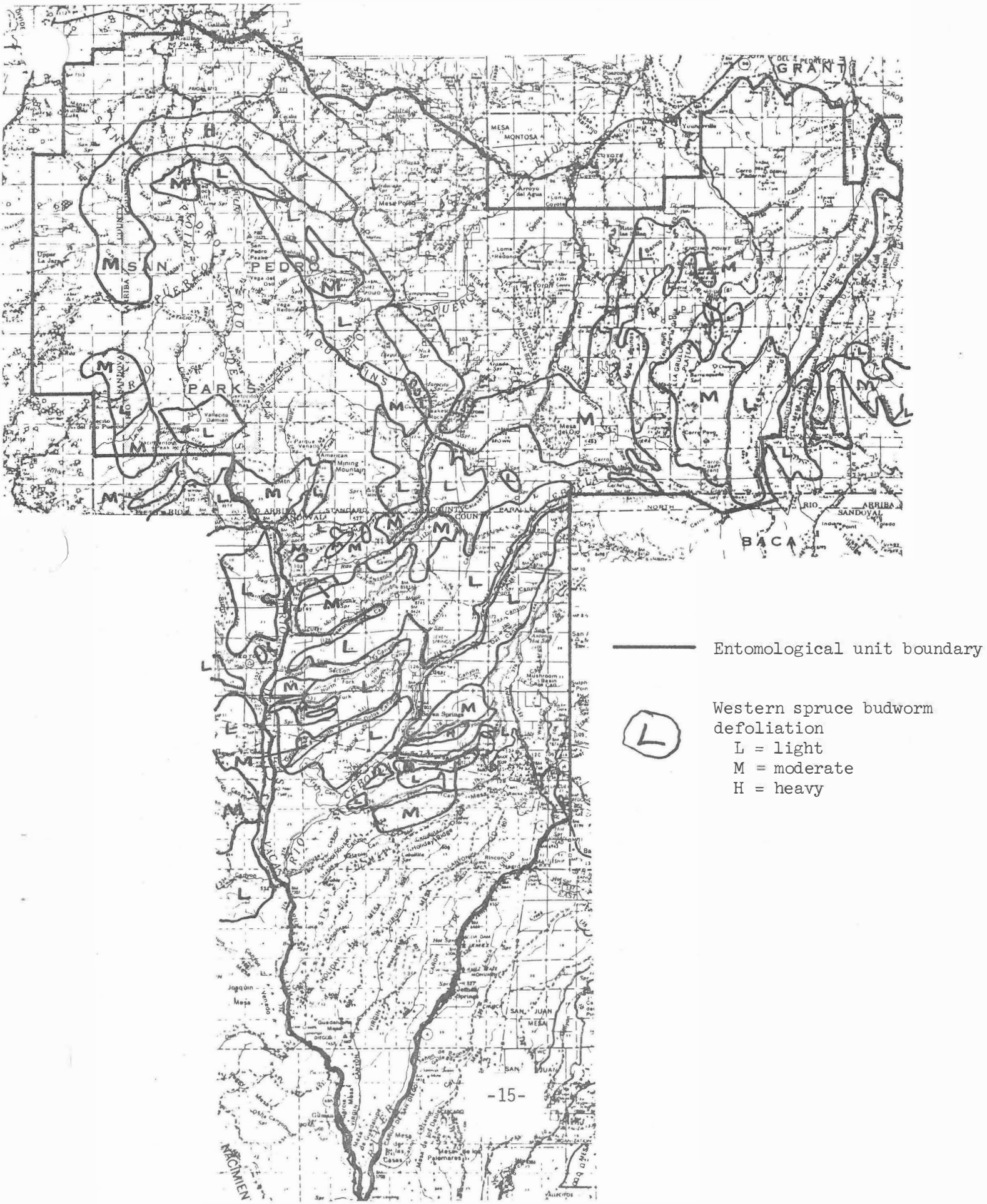
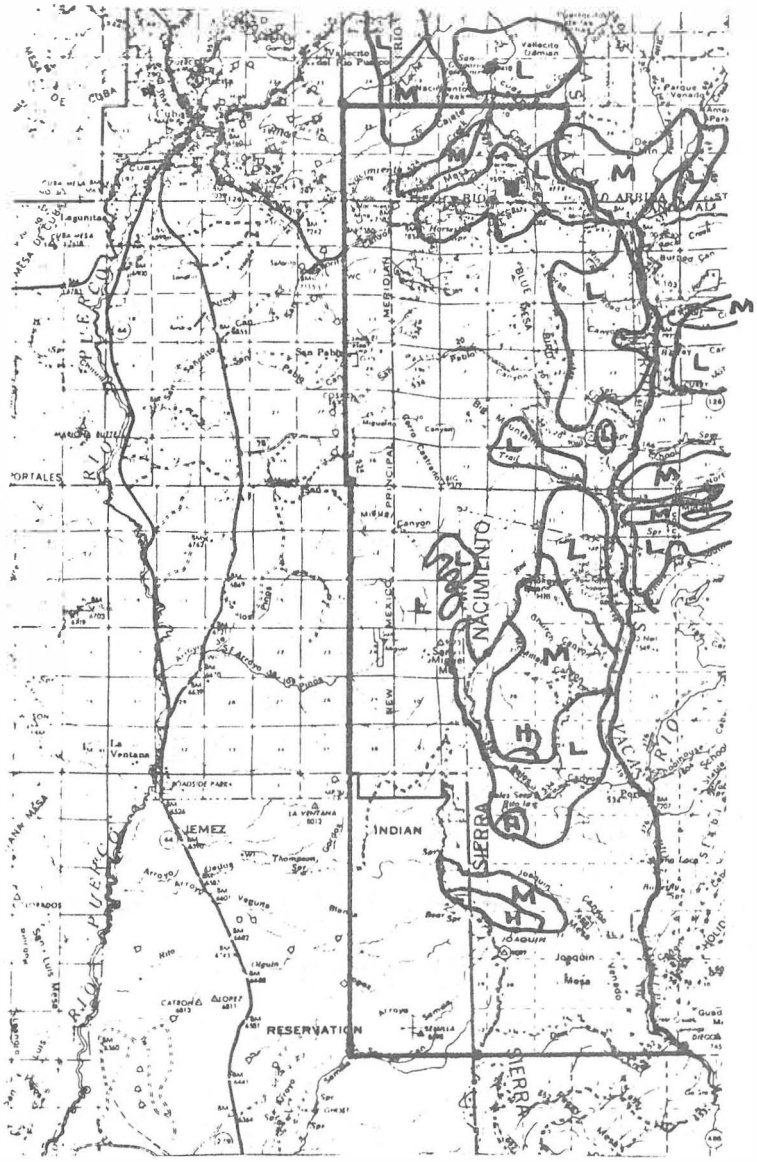


FIGURE 3.--Western spruce budworm defoliation, Jemez Spray entomological unit, Santa Fe National Forest



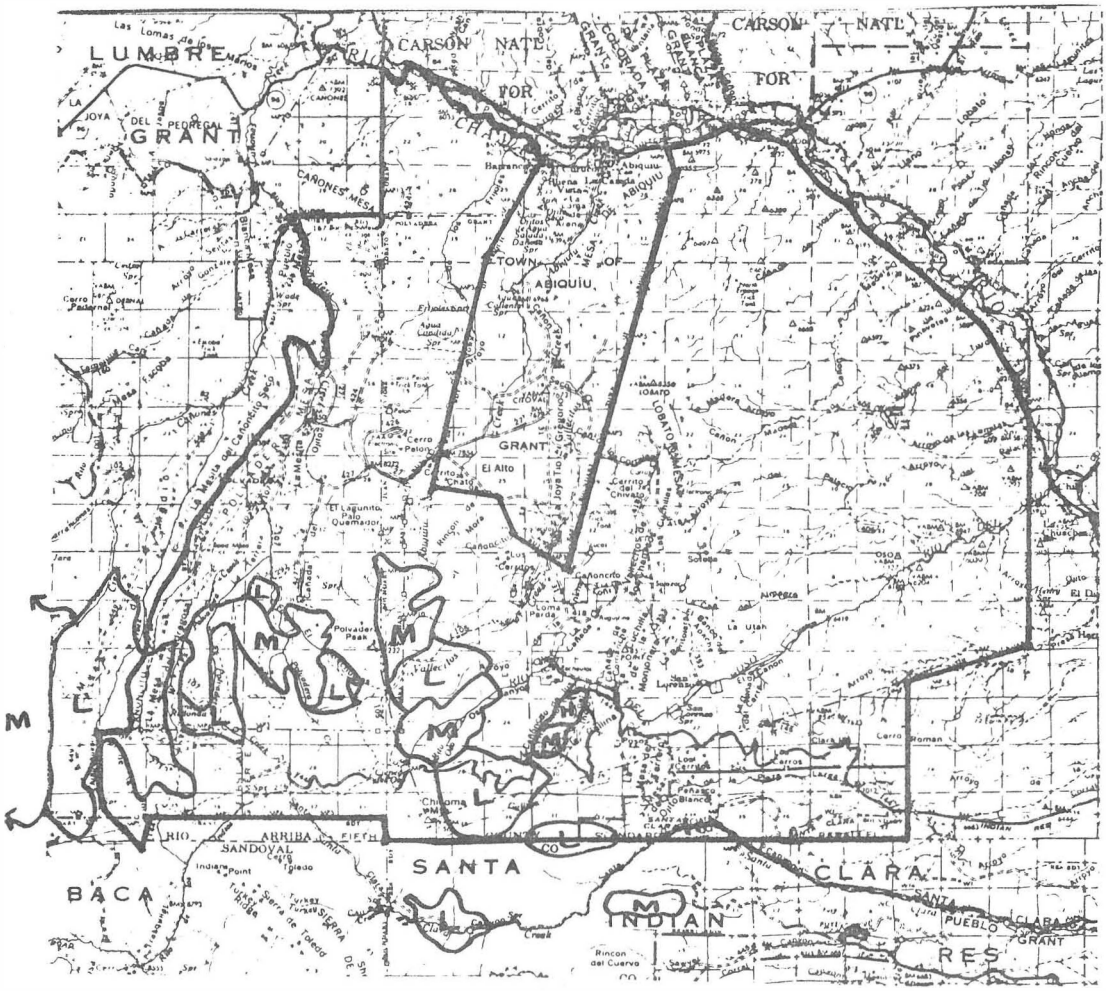
Entomological unit boundary

Western spruce budworm defoliation
L = light
M = moderate
H = heavy

FIGURE 4.--Western spruce budworm defoliation, Jemez North entomological unit, Santa Fe National Forest, 1982

——— Entomological unit boundary

(L) Western spruce budworm defoliation
L = light
M = moderate
H = heavy



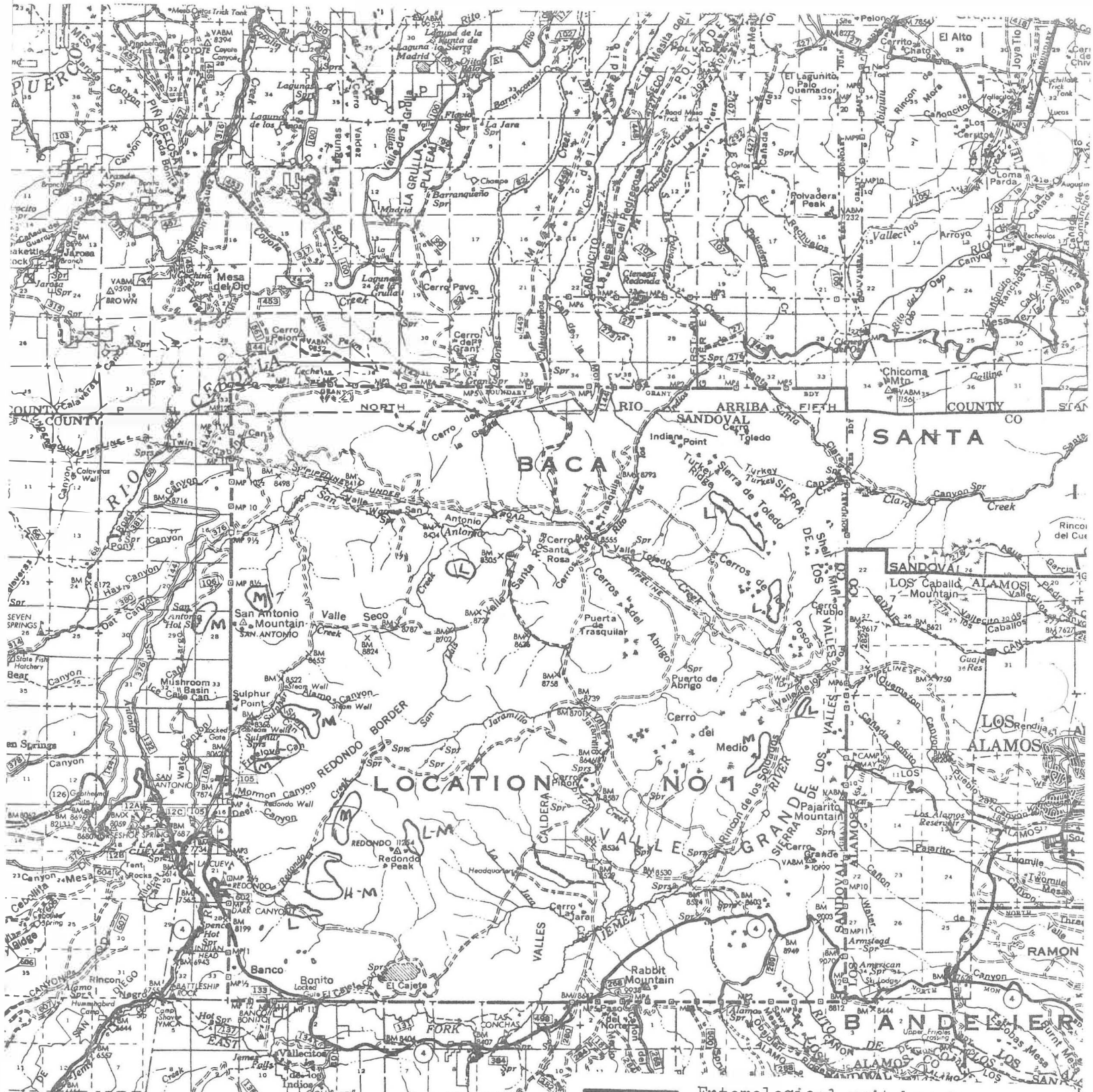
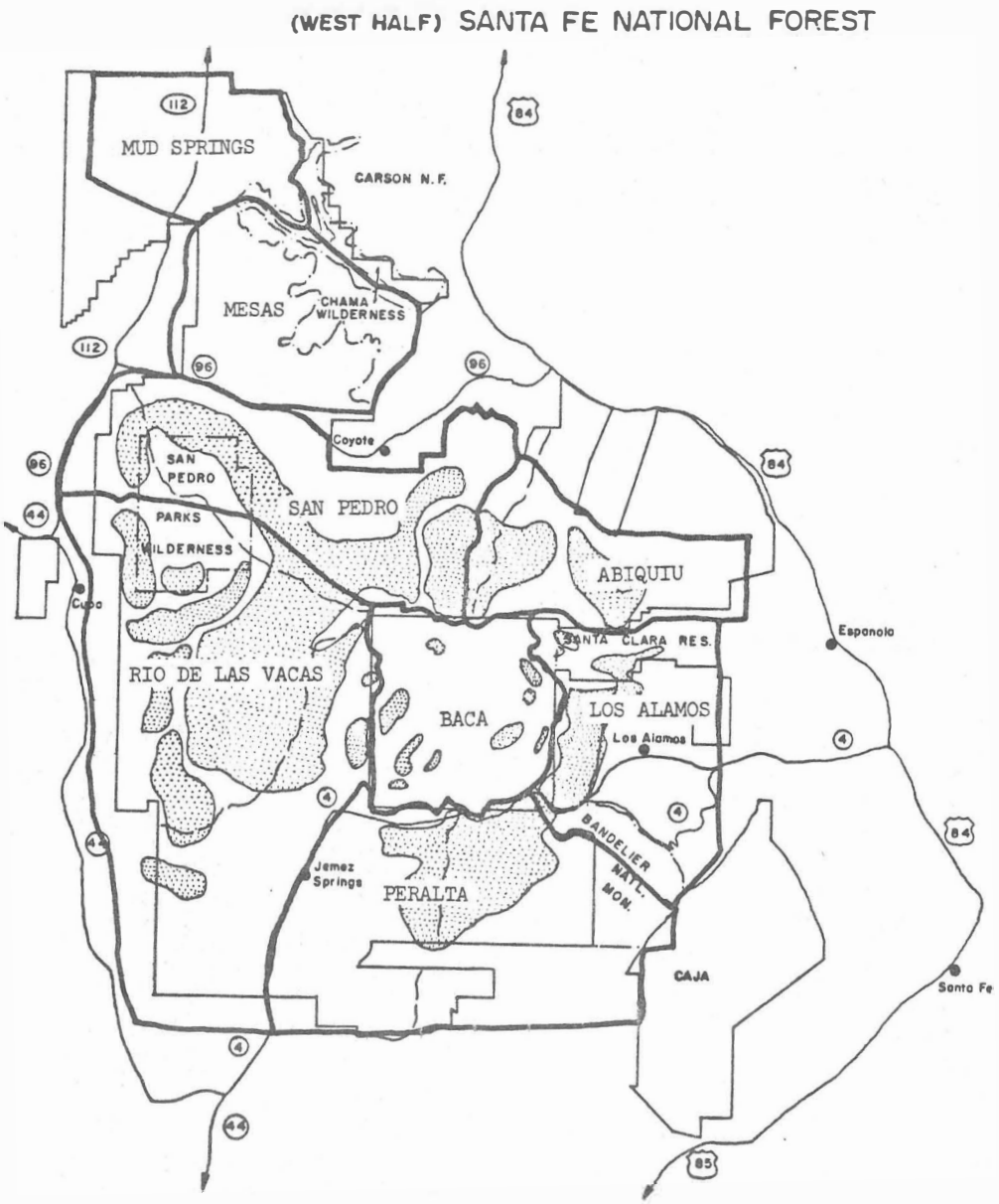


FIGURE 5.--Western spruce budworm defoliation, Baca Location No. 1, Jemez Mountains, New Mexico

FIGURE 6.--Santa Fe National Forest western spruce budworm draft environmental impact statement analysis units



Analysis Units

Forest Boundary

Infested Area

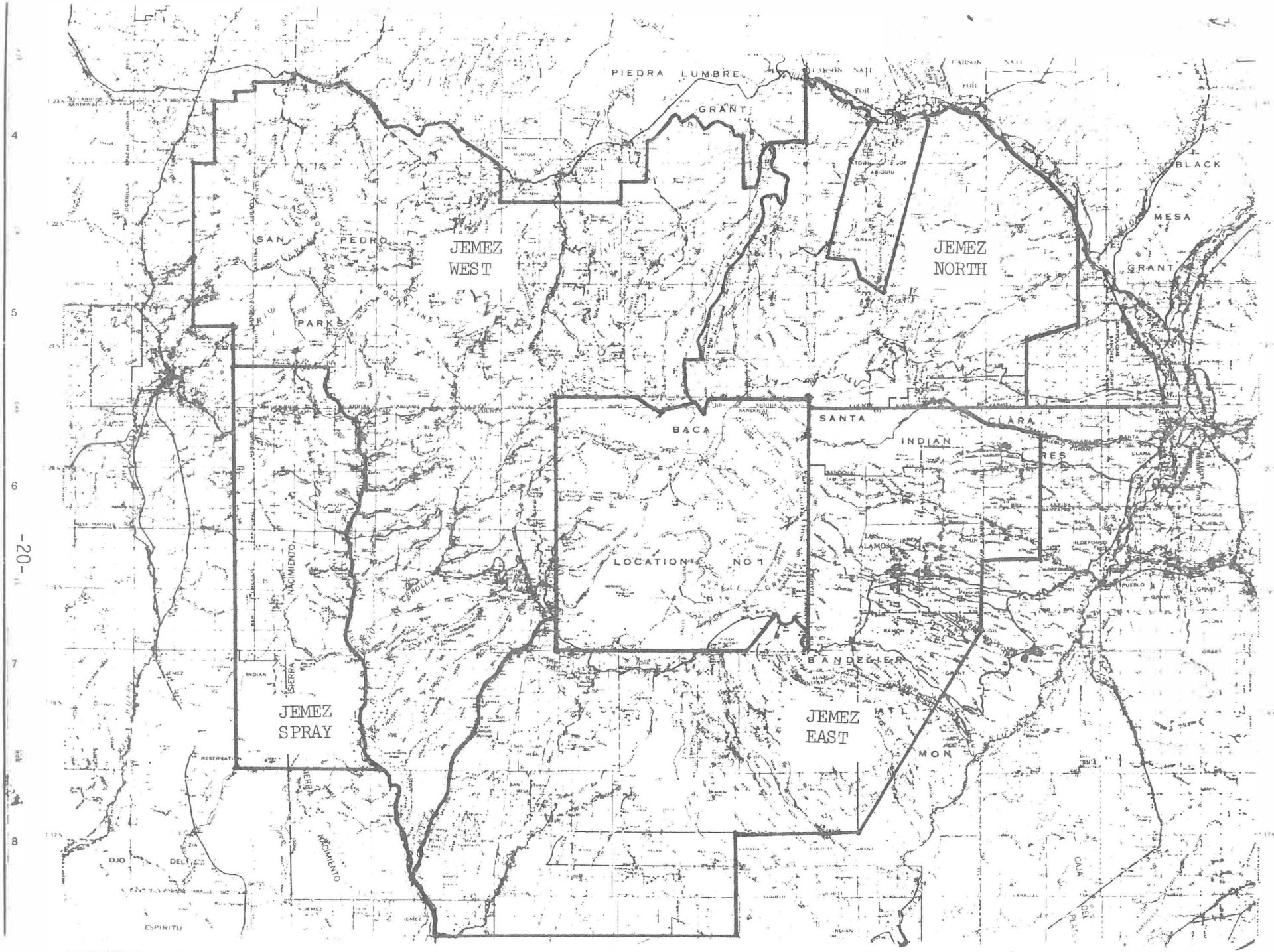


FIGURE 7.--Location of entomological units on the west half, Santa Fe National Forest, 1982.

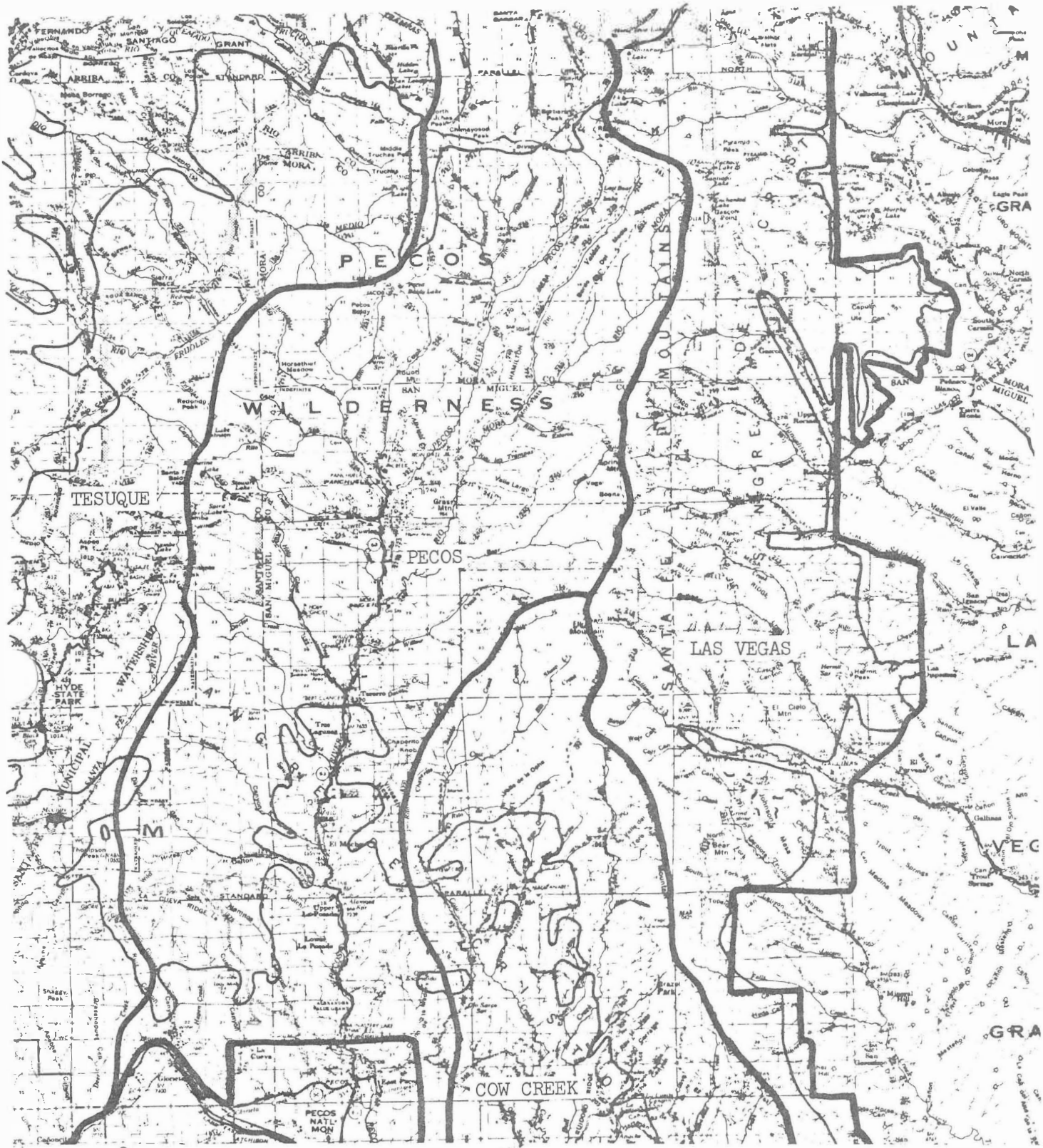


FIGURE 8.--Western spruce budworm defoliation, Tesuque entomological unit, Santa Fe National Forest, 1982